MERMAT 2013

2nd International Workshop on Measurement-based Experimental Research, Methodology and Tools

May 7th, 2013 - Dublin, Ireland

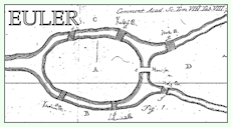
Topics of Interest | Workshop Program | Camera-Ready Submission | Organizing Committee | Program Committee | Location and Venue

About the Workshop

Measurement and associated tools play nowadays a fundamental role in iterative experimental research. This role includes the evaluation of protocols, systems and their associated components, etc. functionality and performance by means of reliable and verifiable tools following a systematic methodology. It is also anticipated that distributed measurement and associated tools will also become prominent in the context of operation and management of autonomic information communication infrastructures, at the equipment and monitoring level but also in support of higher-level control functionality such as on-line data analysis mining and diagnostic.

This workshop, co-located with Future Internet Week (FI Week) 2013, aims at gathering all research projects and initiatives under the measurement-based experimental research, methodology and tools thematic. Participants are invited to present their current research and developments on measurements and associated tools in the context of experimental research including simulation, emulation, prototypes, etc.

Sponsors



Important Dates

- Submission of papers:
  ~~Extended to April 12th, 2013~~
- Notification of acceptance:
  ~~April 22nd, 2013~~
- Camera-ready submission:
  ~~April 29, 2013~~

Topics of Interest

Workshop topics include (but are not limited to):

- Measurement techniques and tools specialized for traffic spatio-temporal properties, network and routing topology/properties, protocol performance, wireless/wireline technologies, etc. in experimental settings
- Methods and techniques to generate repeatable, reproducible, and reliable measurements in experimental homogeneous/heterogeneous settings
- Methods, techniques, and tools to reproduce representative experimental conditions
- Measurement verification and comparison methods and techniques
- Extrapolation and interpolation techniques
- Sampling techniques, calibration / timing and synchronization techniques, etc.
- Large-scale simulation and emulation distributed measurement methodology, tools, etc.
- Distributed measurement techniques and tools for test-beds/experimental facilities including small to large-scale test-beds, federated test-beds, homogeneous/ heterogeneous test-beds, etc.
- Advances on distributed measurement: agents, platforms and on-line analysis
- Data-mining, interpretation, knowledge acquisition from experimental measurements
- Modeling/analyzing experimental data by time series (frequency-domain/time-domain methods, parametric and non-parametric methods, univariate/multivariate) for exploratory analysis, prediction and quantitative forecasting, regression analysis, etc.
- Multivariate experimental data analysis, e.g., analysis of variance, regression analysis, principal component analysis and variants, discriminant analysis and variants, etc.
- Estimation methods and techniques using experimental data
- Interval estimation and statistical hypothesis tests using sample of experimental data

Workshop Final Program

Workshop Leaflet (including abstracts)

10:30 Welcome and Introduction
10:45 Coffee break
11:15 Session 1
11:15 Invited Speaker 1 — Ingrid Moerman (Ghent University - iMinds, Department of Information Technology (INTEC), Belgium)
Title: “Wireless experimentation: An experimenter’s viewpoint” [Presentation Slides PPTX]
11:40 Investigation of One-Way Delay Variation in Substrate and Slice Measurements over a European-wide Future Internet Platform [Presentation Slides PDF]
Susanne Naegele-Jackson, Peter Kaufmann
12:05 The EVARILOS Benchmarking Handbook: Evaluation of RF-based Indoor Localization Solutions [Presentation Slides PPTX]
Tom Van Haute, Eli De Poorter, Jen Rossey, Ingrid Moerman, Vlado Handziski, Arash Behboodi, Filip Lemic, Adam Wolisz, Niklas Wiström3, Thiemo Voigt, Pieter Crombez, Piet Verhoeve, Jose Javier de las Heras
12:30 Lunch break
13:45 Session 2
13:45 A Framework for Modeling and Execution of Infrastructure Contention Experiments [Presentation Slides PPTX]
Carmelo Ragusa, Philip Robinson and Sergej Svorobej
14:20 Network design for the LOG-a-TEC outdoor testbed [Presentation Slides PPTX]
Tomaz Solc, Zoltan Padrah

15:00 Coffee break
15:30 Session 3
11:15 Invited Speaker 2 — Dimitri Papadimitriou (Alcatel-Lucent Bell Labs, Belgium)
Title: "Program verification in software-based experimental facilities" [Presentation Slides PPTX]
15:55 Reducing Power Consumption in Body-centric Zigbee Communication Links by means of Wearable Textile Antennas [Presentation Slides PPTX]
P. Vanveerdeghem, B. Jooris, P. Becue, P. Van Torre, H. Rogier, I. Moerman, and J. Knockaert
16:30 Presentation of the "Measurement Tools and Dataset repository" initiative. [Presentation Slides PPTX]
Please visit www.mtoolsanddata.org for more information.
17:00 End of MERMAT

Accepted as a poster:
A Network Traffic Classification based on Coupled Hidden Markov Models [Presentation Slides PPTX]
Fei Zhang, Wenjun Wu

Camera-Ready Submission

Authors should only submit original work that has not been published before and is not under submission to any other venue.

All submissions must be written in English with a minimum of 4 and a maximum of 6 double-column pages (10 point font) including references and figures. All papers must be formatted according to the IEEE manuscript template for conference proceedings:

http://www.ieee.org/conferences_events/conferences/publishing/templates.html

At least one author must register to FIA Dublin 2013. The minimum registration is €50 for the *Pre FIA Workshop Day Tuesday May 7th* event, which includes lunch, teas/coffees and delegate gift bag.

STEP 1: Enter a valid e-mail address

To initiate the submission of the camera-ready version of an accepted paper, please enter a valid e-mail address:

(this will be the contact address for the submission)

Submit

Organizing Committee

General Chair

- Dimitri Papadimitriou, Alcatel-Lucent Bell Labs

Treasurer/Financial Chair

- Davide Careglio, Univ. Politècnica de Catalunya, Spain

Publication Chair

- Lluís Fàbrega, Univ. of Girona, Spain

Technical Program Committee Co-Chairs

- Pere Vilà, Univ. of Girona, Spain
- Ingrid Moerman, Ghent Univ., Belgium

Webmaster

- Antonio Bueno, Univ. of Girona, Spain

Program Committee

- Pere Barlet, Universitat Politècnica de Catalunya, Spain
- Pierre Borgnat, Phys-ENS Lyon, France
- Periklis Chatzimisios, Alexander Technological Educational Institute of Thessaloniki, Greece
- Piet Demeester, Ghent University, Belgium
- Panagiotis Demestichas, University of Piraeus, Greece
- Stefano Giordano, Università di Pisa, Italy
- Luc Hogie, CNRS INRIA Sophia-Antipolis, France
- Scott Kirkpatrick, The Hebrew University of Jerusalem, Israel
- Philippe Owezarski, LAAS-CNRS Toulouse, France
- Charalambos Skianis, University of the Aegean, Mytilene, Greece
- Fabien Tarissan, UPMC-CNRS, Paris, France
- Sandrine Vaton, Telecom Bretagne, Brest, France

Location and Venue

The Helix Center is located on Dublin City University (DCU) Campus in Glasnevin, North Dublin.

Further details on the Helix location and venue, as well as a transportation guide, can be found in the venue website.

Wireless experimentation
An experimenter's viewpoint

Ingrid Moerman, Wei Liu & Peter De Valck - iMinds

The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 258301 (CREW project).

Outline

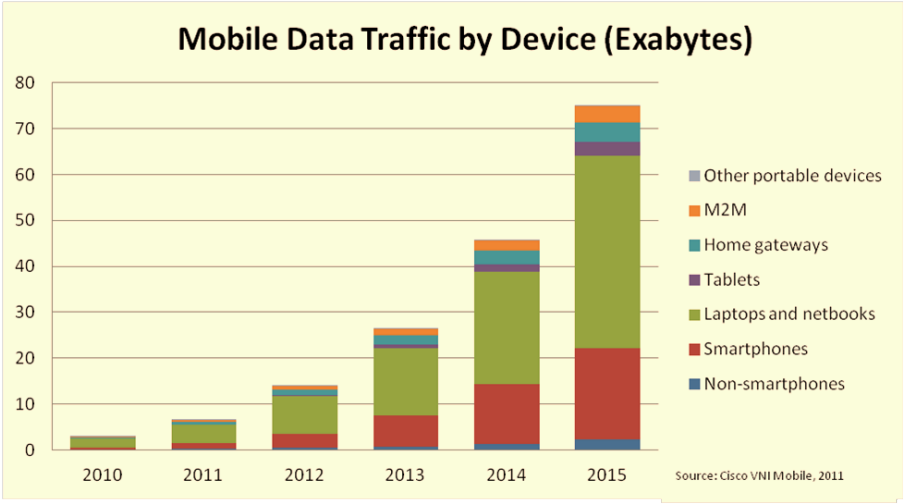
- **An experimenter's viewpoint**
  - Case: the CREW platform
  - Case: spectrum sensing
- **Reducing the learning threshold for experimentation**
  - Approach: common cognitive radio language
  - CREW-GENI collaboration

CREW – Why?

The Internet plays a crucial role in interconnecting technologies and services…

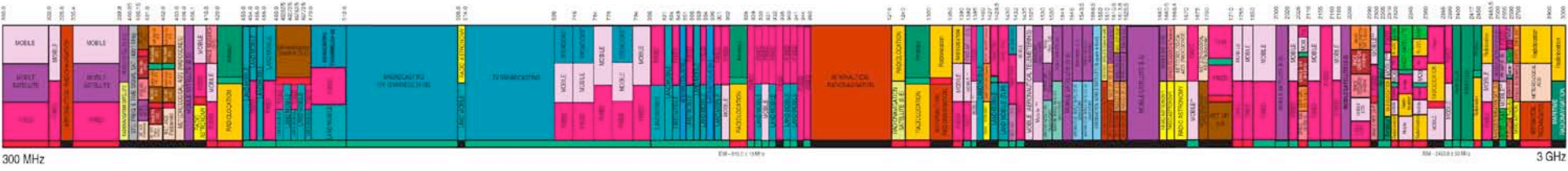
… resulting in increasing complexity

- more users, more types of users
- more devices, more types of devices (Internet of Things)
- **increasing wireless traffic demand!**



BUT… radio spectrum is limited!

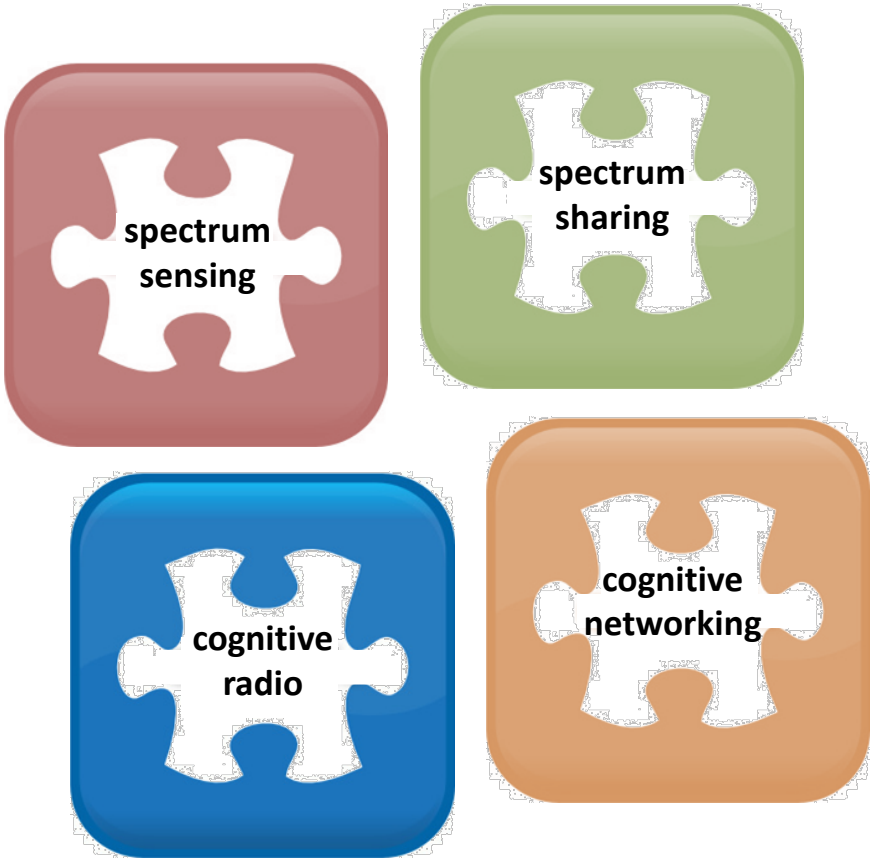
- big differences depending on the frequency band
  - white spaces in licensed bands versus overcrowded unlicensed bands

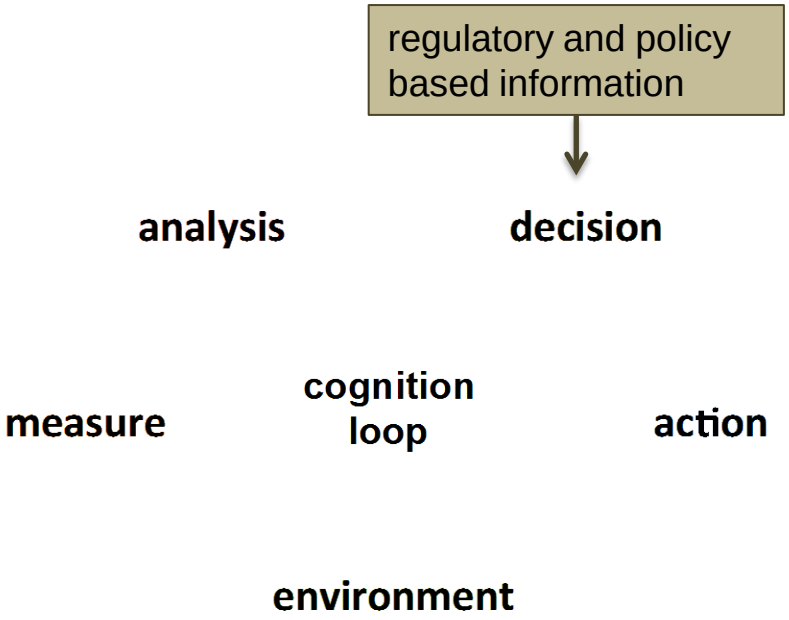


CREW – Why?

Solution: cognitive radio – cognitive networking

- Use the available (spectrum) resources as efficiently as possible, by adapting the radios (transmitters and receivers) to the wireless environment and the user needs

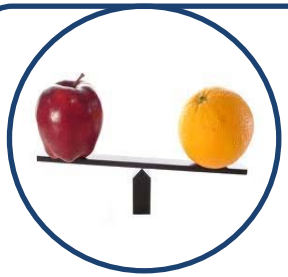




CREW – Why?

From novel idea to commercial use …

… experimentally-supported research is crucial for validation of new CR/CN concepts



compare the performance of multiple solutions

theory vs. reality: impact of real-life deployment

showcase for industry, regulators and government

reduce the time to market

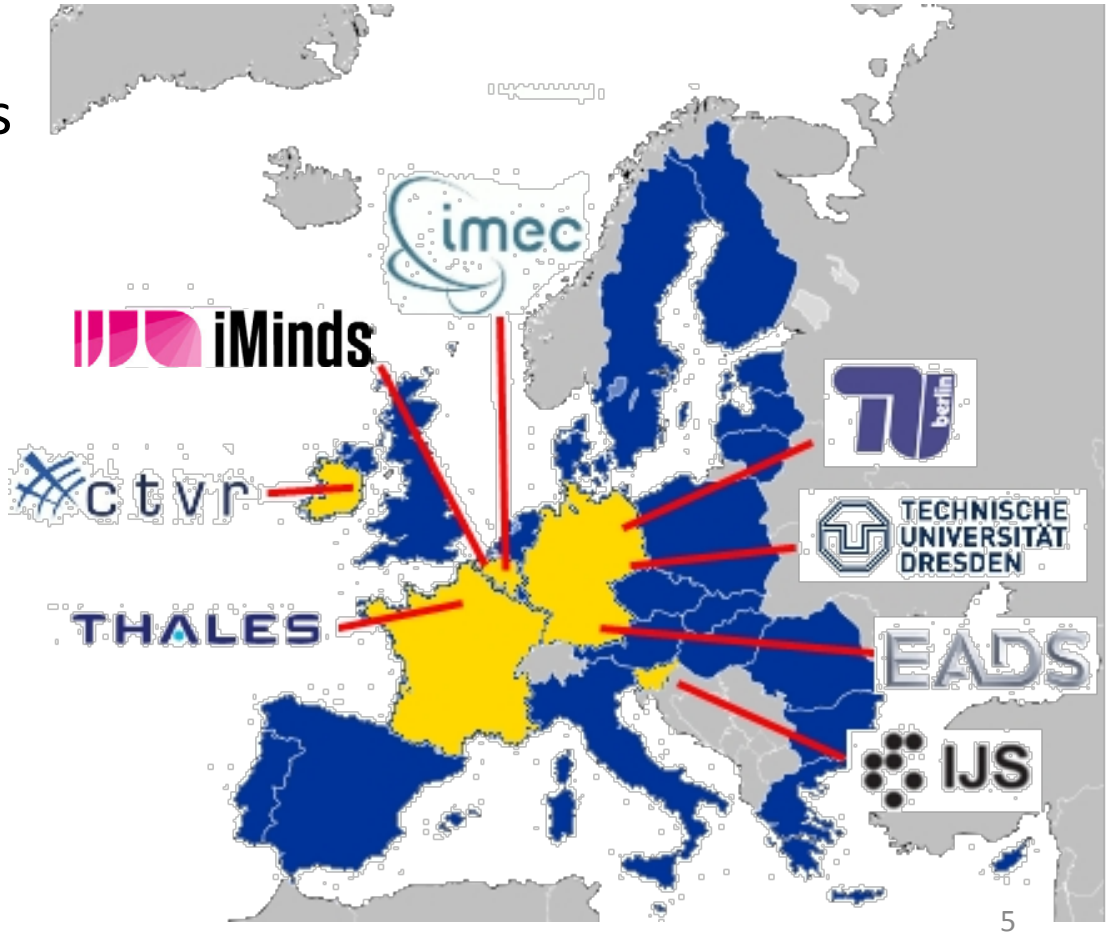
understand how people experience and use technology

Cognitive Radio Experimentation World

- FP7 call 5 (FIRE - Future Internet Research and Experimentation Initiative)
- Project started October 2010
- 8 core partners
- 3+6 open call partners
  - UDUR (UK)
  - TUIL (DE)
  - TECNALIA (ES)

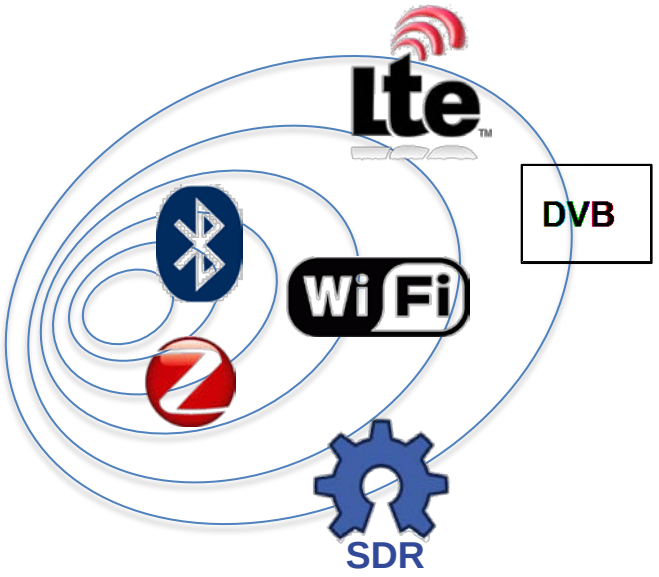
  OC1
  - IT (PT)
  - CMSF (PT)
  - CNIT (IT)
  - WINGS (GR)
  - UTH (GR)
  - NICTA (AU)

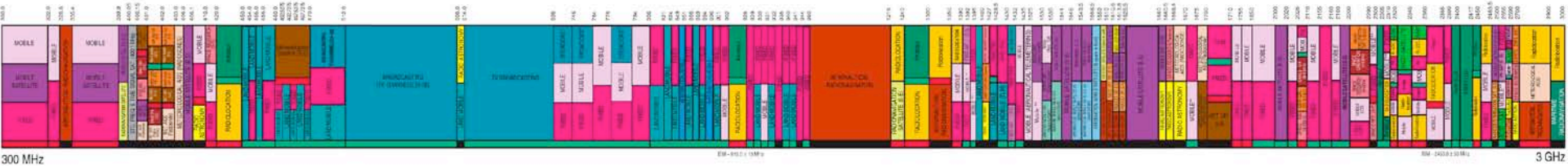
  OC2



IP CREW: Target

- **establish an open federated test platform, facilitating experimentally-driven research on**
  - advanced spectrum sensing
  - cognitive radio (CR)
  - cognitive networking (CN)
  - spectrum sharing
    in licensed and unlicensed bands





CREW federated platform

heterogeneous ISM
@ Ghent (iMinds)

WinnF Transceiver Facility (API)

wireless sensor
@ Berlin (TUB)

IMEC sensing agent

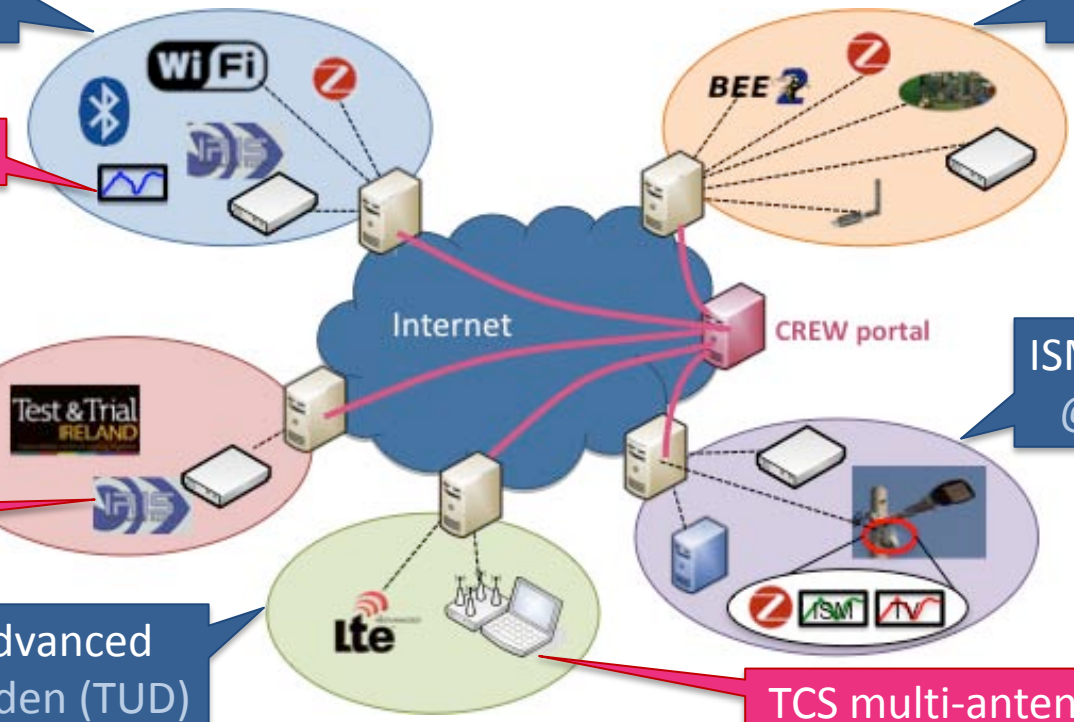
TV-bands
@ Dublin (TCD)

IRIS SW radio

ISM/TVWS outdoor
@ Ljubljana (JSI)

LTE-advanced
@ Dresden (TUD)

TCS multi-antenna LTE detection



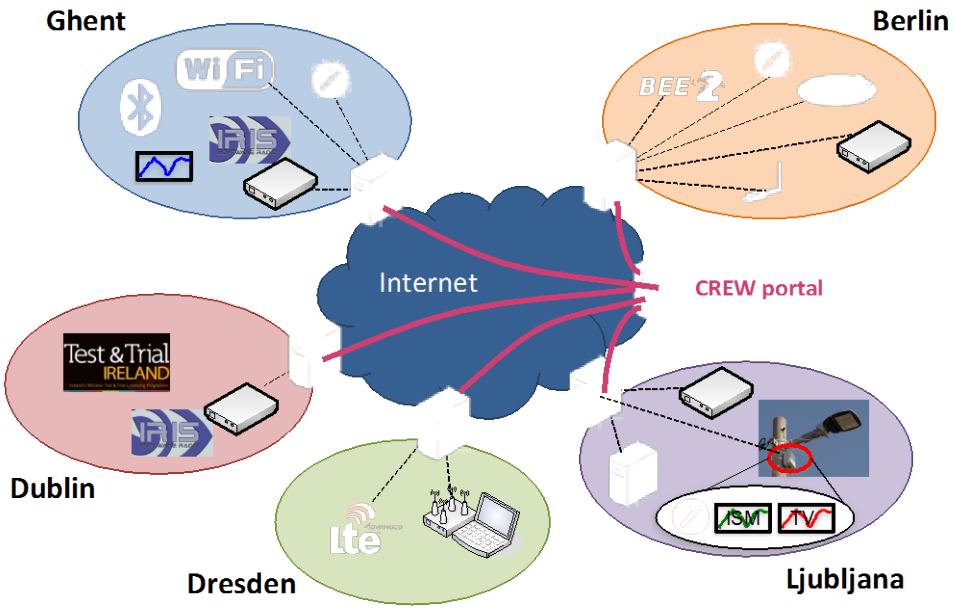
IEEE 802.11
IEEE 802.15.1
IEEE 802.15.4
LTE-advanced
EyesIFX nodes
CR database

IRIS GPP-based software radio platform
Comreg spectrum licenses
BEE2 FPGA platform
USRP software radio
VESNA platform on light pole

IMEC Sensing Agent
UHF/VHF TV sensing
ISM bands sensing
TCS Multi-antenna LTE detection
WiSpy Spectrum analyzer
Interconnection of portals
Interconn. between testbed elements

The CREW offer

- **Open access to 5 different testbed islands and advanced cognitive components**
  - different wireless technologies
  - different spectrum bands
  - mature testbeds
  - methodologies and tools for experimentation
  - reproducible test conditions
  - expertise from PHY layer up to application layer



- **Portal with detailed information and guidelines on access and use of the facilities (www.crew-project.eu)**

- **Technical support & assistance to your experiments**
  - methodologies for experimentation
  - upcoming open call 3 for free and guaranteed support to your experiment

The experimenter's view

At first sight

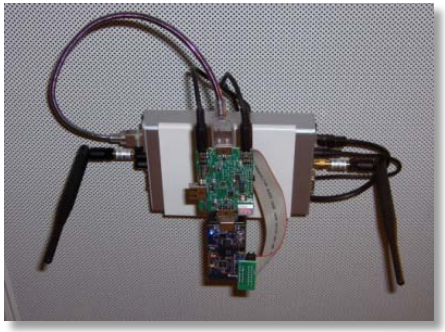
- CREW facilities are exciting…
- … offering many advanced cognitive radio (CR) components

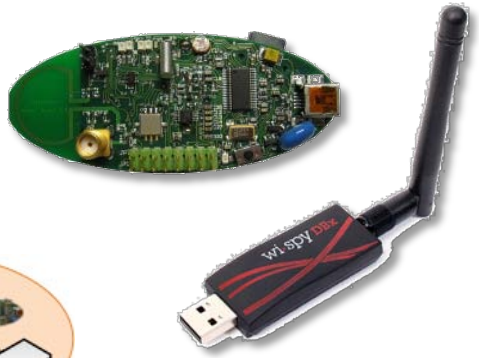
BUT…

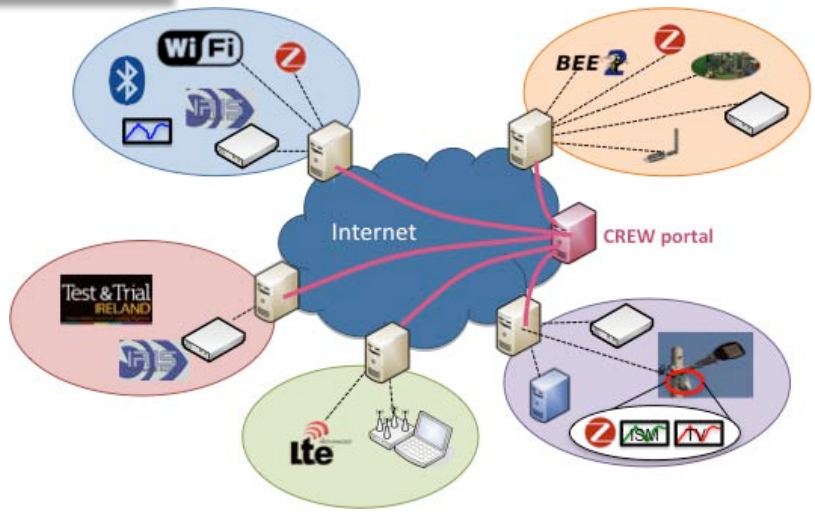
- Which testbed and CR components are most suited for a specific experiment?
- CR components and testbeds are very heterogeneous!
- Much detailed technical information must be absorbed before starting experiment!
- It takes time to familiarize with facilities and CR components…
- …

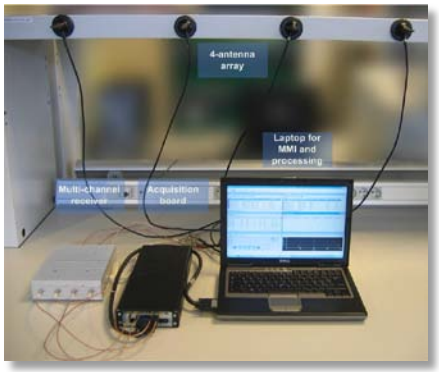
➜ High learning threshold for experimentation!

CREW – advanced CR components





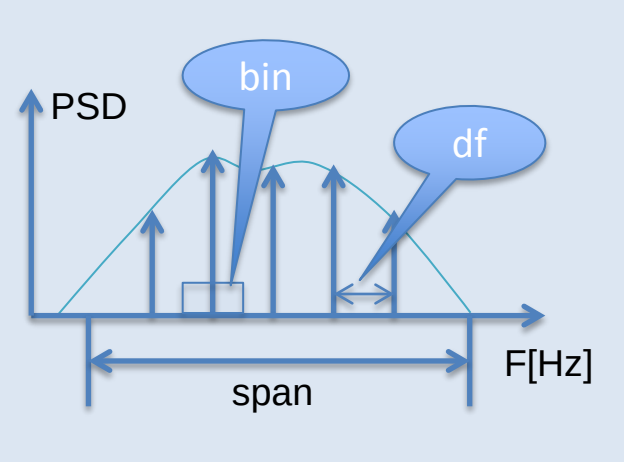


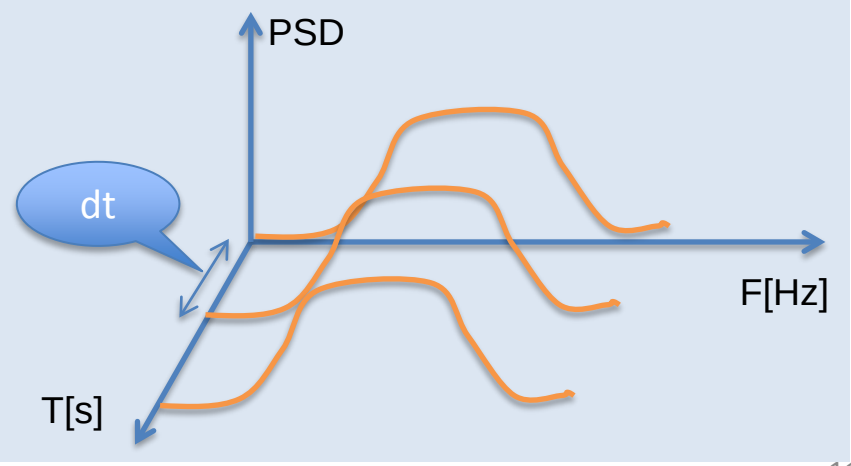


Spectrum sensing - some theory

Spectrum sensing parameters

Parameter	Description
frequency span	spectrum monitoring range
frequency bin	range of frequencies over which spectral amplitude is measured
resolution bandwidth (df)	distance between adjacent frequency bins
sampling time	time used by RF front-end to collect samples from the air
processing time	time to process samples in case sampling and processing happens sequentially extra time to process samples in case sampling and processing happens in parallel
sweep time (dt)	the sum of sampling time and processing time

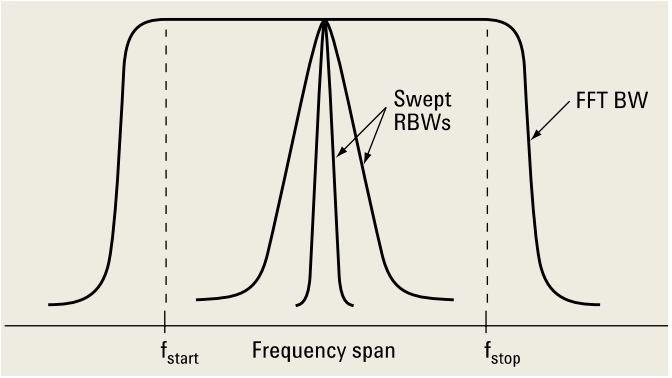




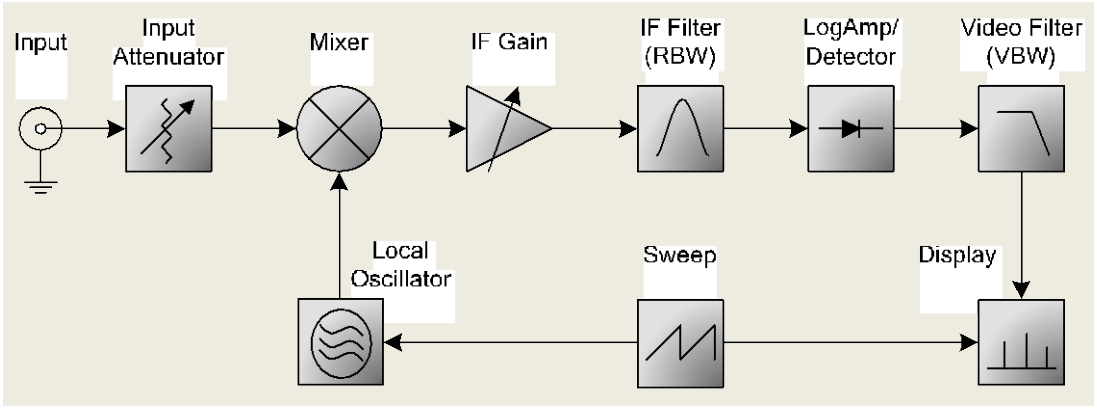
Spectrum sensing - some more theory

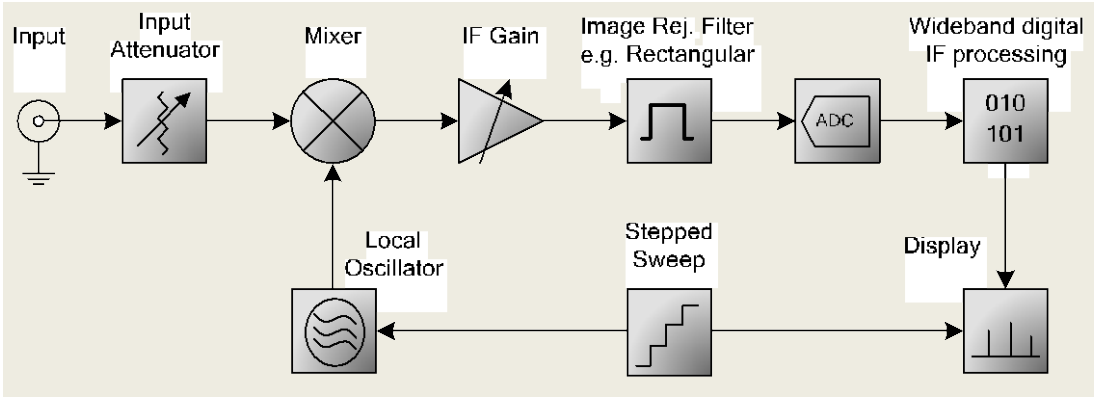
Swept mode versus Fast Fourier Transform (FFT) mode

swept mode = narrowband
radio frequency (RF) center frequency is incremented rapidly in small steps



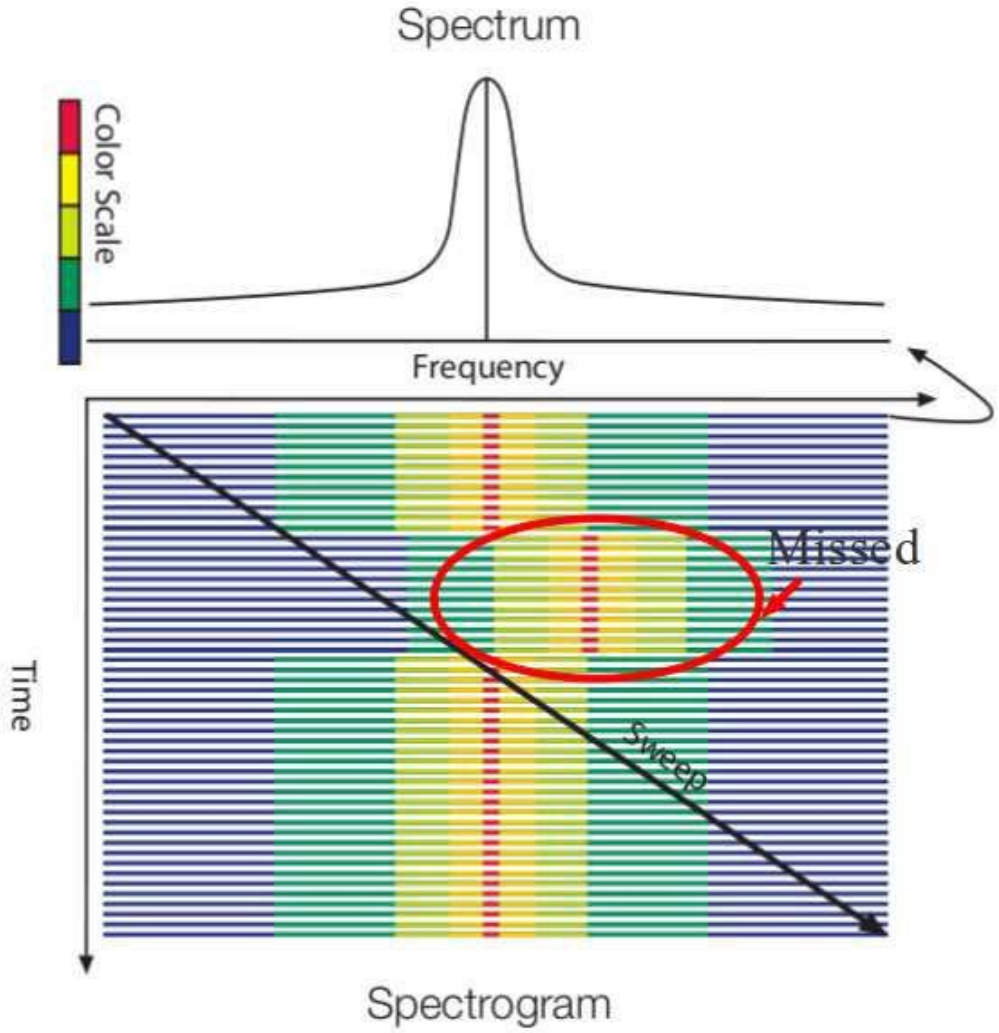
FFT= wideband
transformation from time domain to frequency domain is achieved by FFT (frequency span depends on sample rate)





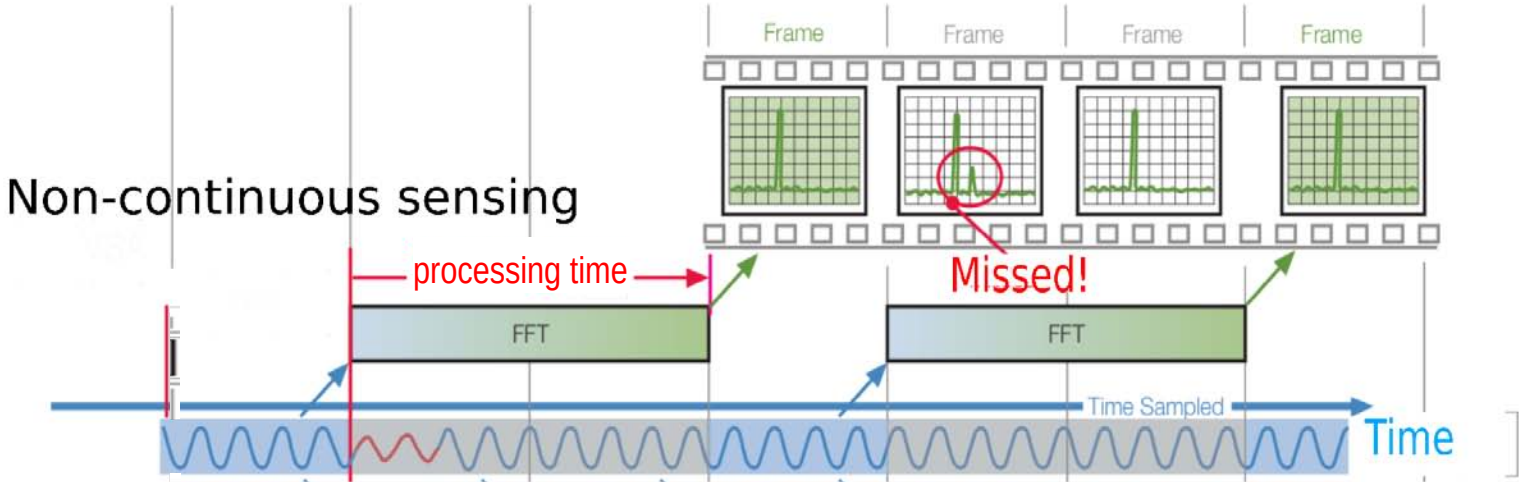
Problems with spectrum sensing

- **Swept mode**
  - Missed signals during sweeping



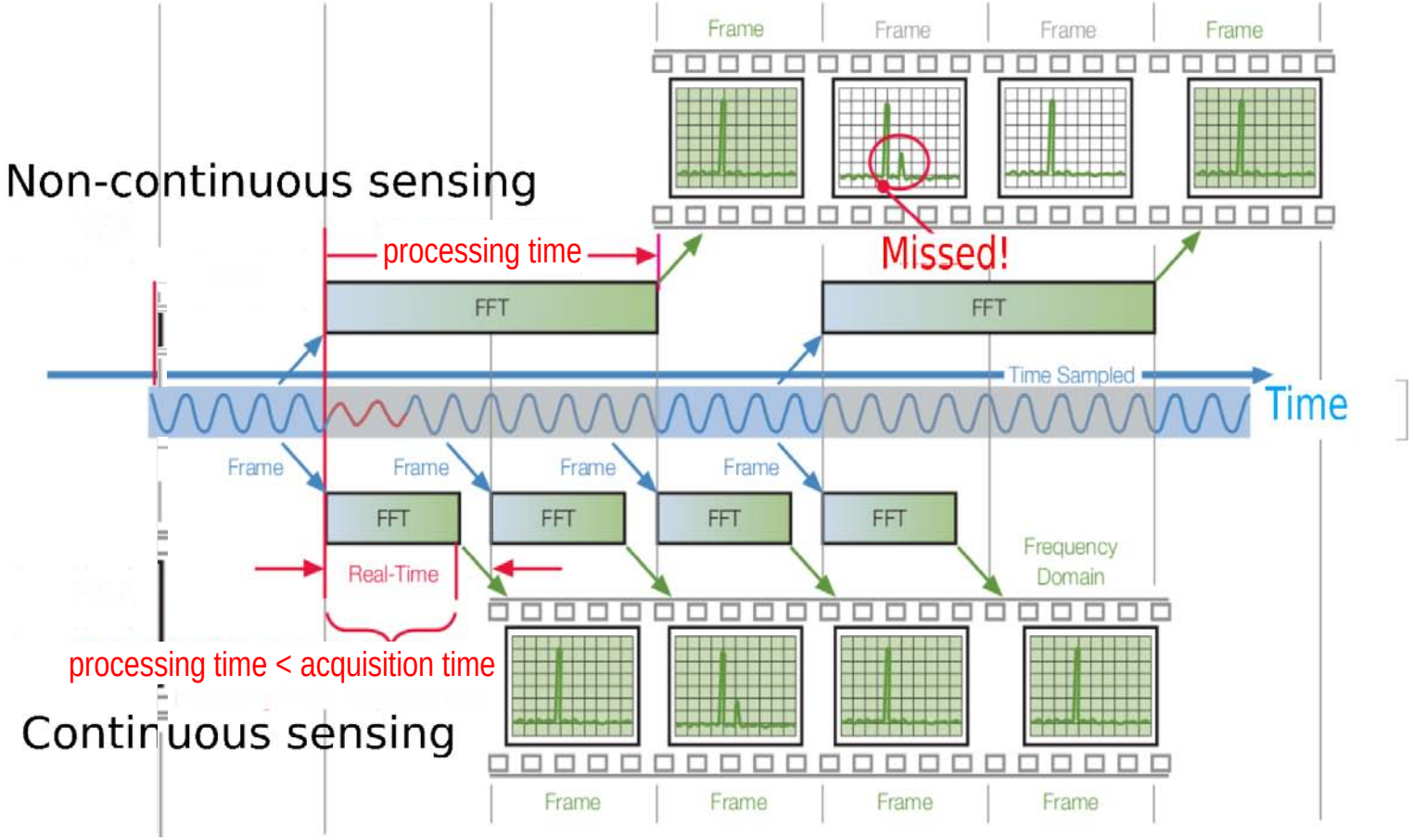
Problems with spectrum sensing

- **FFT mode**
  - First acquisition of samples, then processing
  - Missed signals in case of non-continuous processing



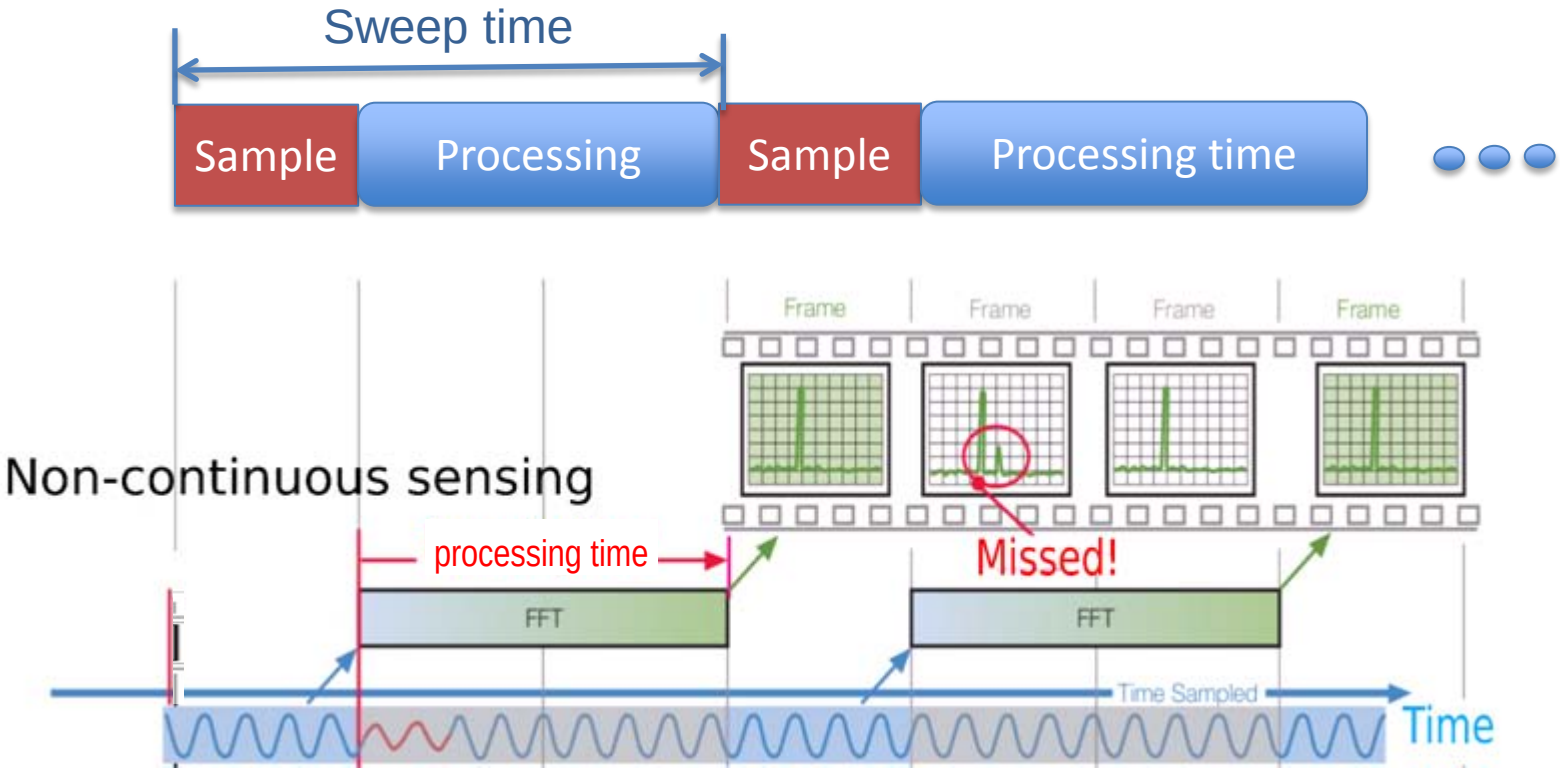
Problems with spectrum sensing

- **FFT mode**
  - First acquisition of samples, then processing
  - Missed signals in case of non-continuous processing



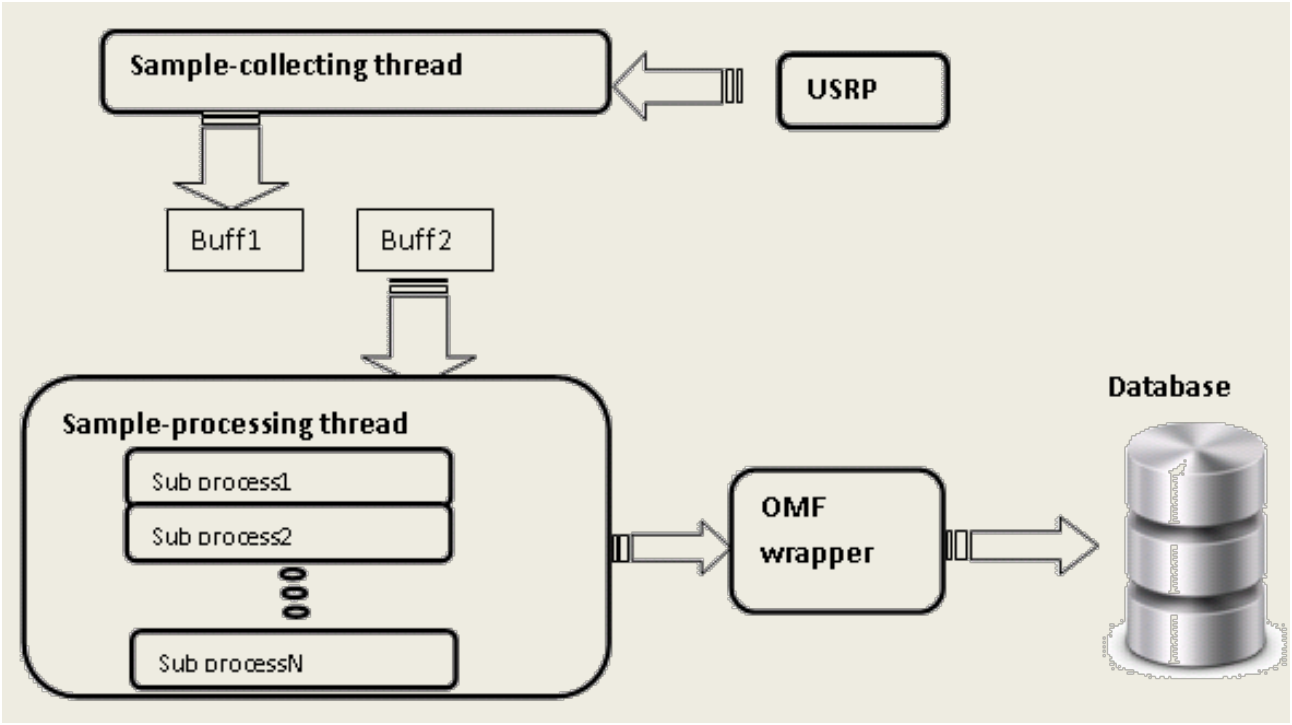
Sensing efficiency

- **FFT mode**
  - **Sensing efficiency** = ratio between sampling time and sweeping time
  - Need for fast processing!



iMinds solution for spectrum sensing

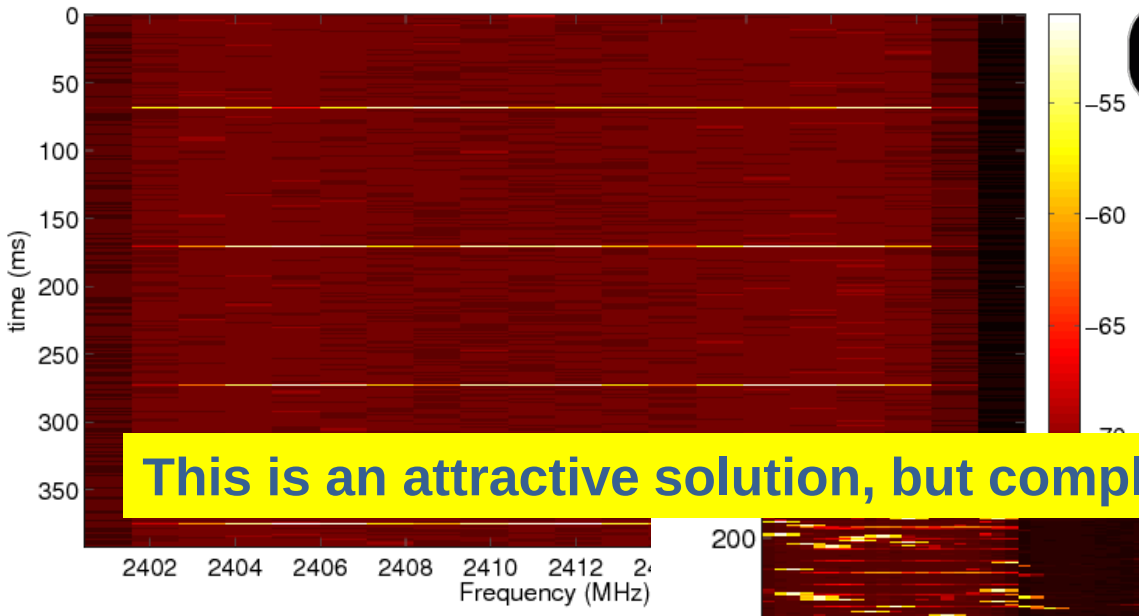
- **USRP + server**
  - Continuous FFT mode
  - Multi-threading → 100% spectrum efficiency
    - 1 thread for sampling
    - 1 thread for processing (several parallel sub threads)
  - **Available for CREW experimenters!**



iMinds solution for spectrum sensing

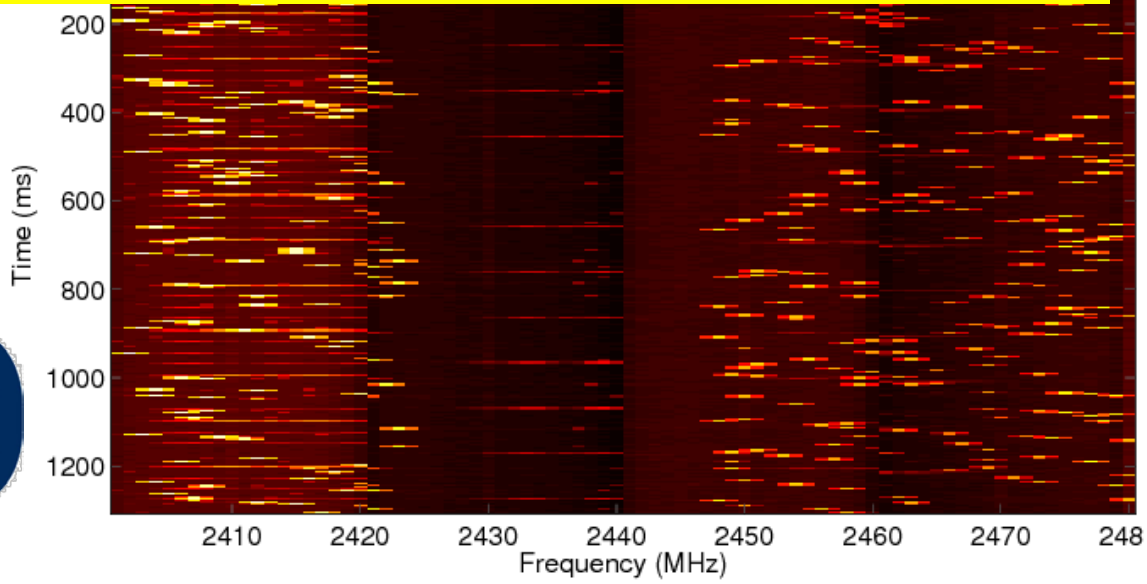
Performance

- Accurate Wi-Fi and Bluetooth detection



1 ms beacons
1% channel occupation

This is an attractive solution, but complex and difficult to use!



frequency hopping
every 625 µs

CREW – GENI collaboration

Motivation

- Many heterogeneous CR devices available (USRP, WARP, imec SA…)
- Learning threshold for setting up end executing a CR experiment is quite high

Goal

- Reduce the learning threshold for wireless experimentation involving cognitive radios by introducing a **common CR language**

Example: experimentation @ iMinds

cognitive radio experiment

reservation, configuration, experiment definition

→ specific knowledge required about the testbed and devices

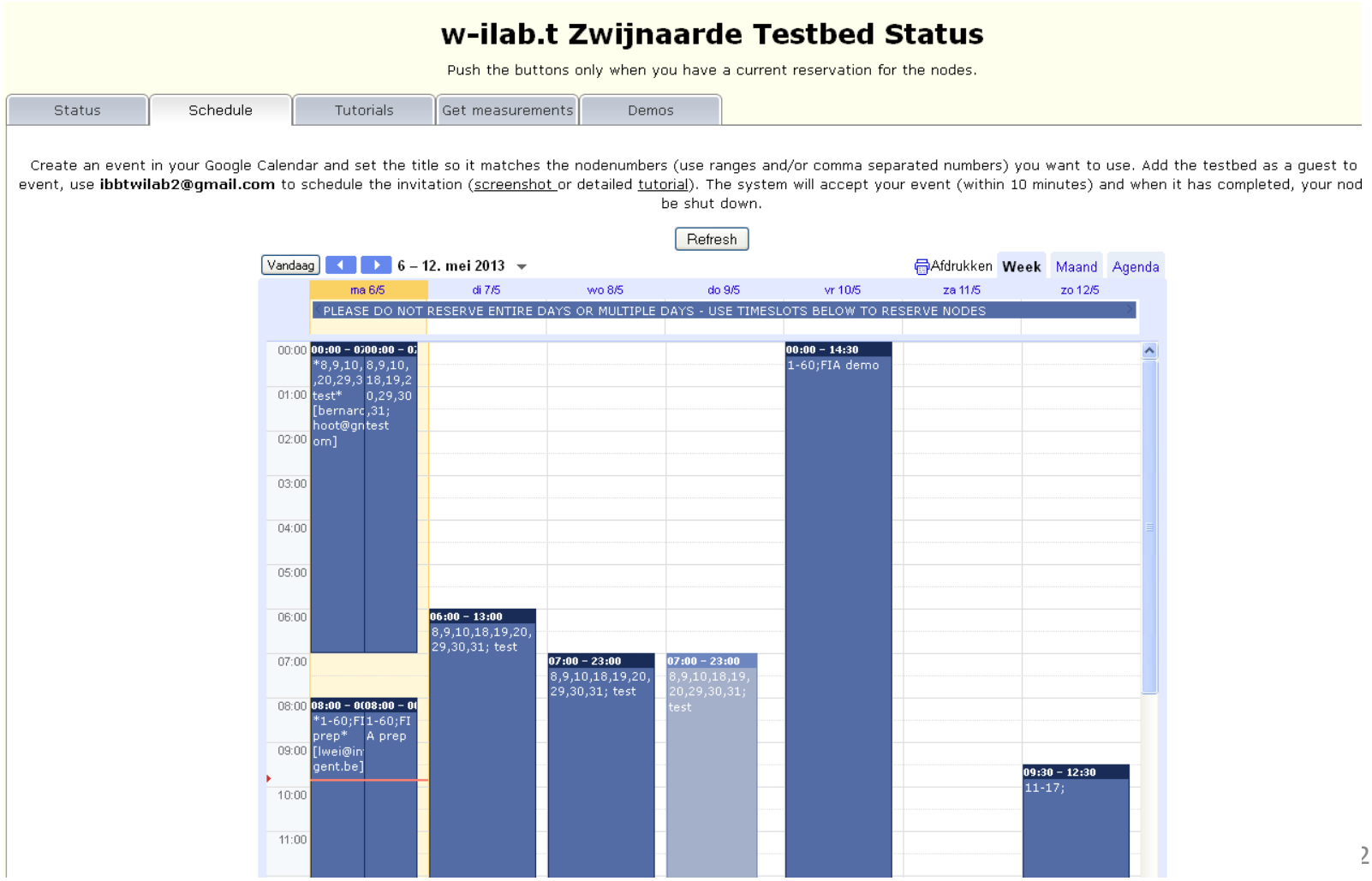
single testbed

iMinds
CONNECT.INNOVATE.CREATE

single device

Example: experimentation @ iMinds

- **USRP sensing solution on the iMinds testlab**
  - Reservation



Example: experimentation @ iMinds

USRP sensing solution @ iMinds

- Configuration
  - Example: definition of spectrum sensing application

```
defApplication('usrpse_sweeping_wrapper', 'usrpse_sweeping_wrapper') do |app|
   app.path = File.join(File.dirname(__FILE__), '/usrpse_tar_extract/usrpse_sweeping_wrapper.rb')
   app.appPackage = "usrpse_sweep_oml.tar"

   # some descriptions
   app.version(1, 0, 0)
   app.shortDescription = "usrpse_sweeping_wrapper"
   app.description = "Simple wrapper for usrpse binary in sweeping mode"

   app.defProperty('gain', 'RF Gain', 'g' , {:type => :string, :dynamic => false})
   app.defProperty('spb', 'Sample per buffer', 's' , {:type => :string, :dynamic => false})
   app.defProperty('fftsize', 'FFT size, determines the granularity', 'n' , {:type => :string, :dynamic => false})
   app.defProperty('args', 'Args for specifying usrp ip address', 'a' , {:type => :string, :dynamic => false})
   app.defProperty('bps', 'block per sweep', 'i' , {:type => :string, :dynamic => false})
   app.defProperty('freqbegin', 'The begining center frequecy of a sweep', 'f' , {:type => :string, :dynamic => false})
   app.defProperty('numofchannel', 'num of channel', 'j' , {:type => :string, :dynamic => false})
   app.defProperty('firstchannel', 'first channel', 'k' , {:type => :string, :dynamic => false})
   app.defProperty('channelwidth', 'channel width', 'l' , {:type => :string, :dynamic => false})
   app.defProperty('channeloffset', 'channel offset', 'o' , {:type => :string, :dynamic => false})

   app.defMeasurement('usrpsemp') do |mp|
        mp.defMetric('timestamp_us',:string)
        mp.defMetric('usrpid',:string)
        for i in 1..12
               mp.defMetric("chan#{i}",:double)
        end
   end
end
```

number of bins

resolution bandwidth (df)

center frequency of bin

Example: experimentation @ iMinds

USRP sensing solution @ iMinds

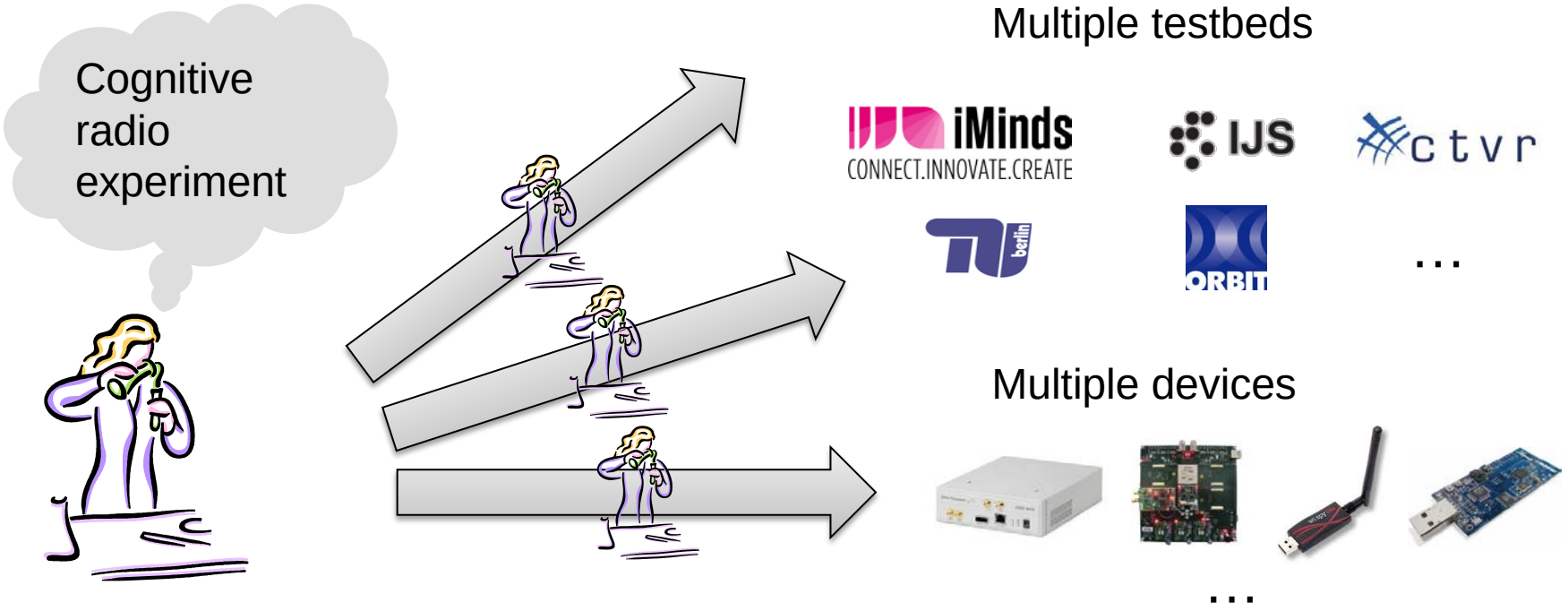
- Experiment definition
  - Example: application running on specific node

add USRP application on server 1

12 (Wi-Fi) channels

```
34 defGroup('server1', "omf.ibbt.open.server1") {|node|
35     node.addApplication('usrpse_sweeping_wrapper') {|app|
36         app.setProperty('gain','20' )
37         app.setProperty('spb','1048576')
38         app.setProperty('fftsize', '512')
39         app.setProperty('args', "10.11.20.1")
40         app.setProperty('bps','4')
41         app.setProperty('freqbegin','2420000000' )
42         app.setProperty('numofchannel', '12')
43         app.setProperty('firstchannel','2422500000')
44         app.setProperty('channelwidth', '5000000')
45         app.setProperty('channeloffset','5000000')
46
47         app.measure('usrpsemp', :samples=>1) do |mp|
48         end
49     }
50 }
```

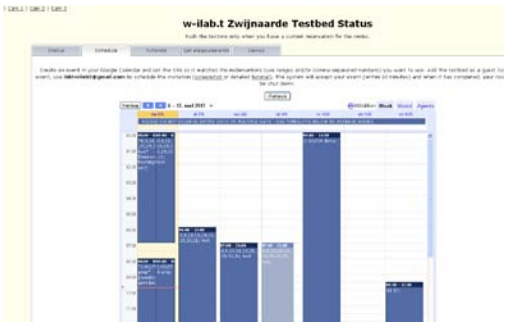
Experimentation at different CREW testbeds



To run similar experiments in different wireless environments using different CR hardware, a researcher needs **specific knowledge for each testbed and type of device** (reservation, configuration, experiment definition)
➔ **duplication of work!**

Example: experimentation @ iMinds

- **USRP sensing solution on the iMinds testlab**
  - CREW – GENI approach




```
defApplication('usrpse_sweeping_wrapper', 'usrpse_sweeping_wrapper') do |app|
  app.path = File.join(File.dirname(__FILE__), "/usrpse_tar_extract/usrpse_sweeping_wrapper.rb")
  app.appPackage = "usrpse_sweep_oml.tar"

  # some descriptions
  app.version(1, 0, 0)
  app.shortDescription = "usrpse sweeping wrapper"
  app.description = "Simple wrapper for usrpse binary in sweeping mode"

  app.defProperty('gain', 'RF Gain', 'g' , {:type => :string, :dynamic => false})
  app.defProperty('spb', 'Sample per buffer', 's' , {:type => :string, :dynamic => false})
  app.defProperty('fftsize', 'FFT size, determines the granularity', 'n' , {:type => :string, :dynamic => false})
  app.defProperty('args', 'Args for specifying usrp ip address', 'a' , {:type => :string, :dynamic => false})
  app.defProperty('bps', 'block per sweep', 'i' , {:type => :string, :dynamic => false})
  app.defProperty('freqbegin', 'The begining center frequecy of a sweep', 'f' , {:type => :string, :dynamic => false})
  app.defProperty('numofchannel', 'num of channel', 'j' , {:type => :string, :dynamic => false})
  app.defProperty('firstchannel', 'first channel', 'k' , {:type => :string, :dynamic => false})
  app.defProperty('channelwidth', 'channel width', 'l' , {:type => :string, :dynamic => false})
  app.defProperty('channeloffset', 'channel offset', 'o' , {:type => :string, :dynamic => false})

  app.defMeasurement('usrpsemp') do |mp|
      mp.defMetric('timestamp_us',:string)
      mp.defMetric('usrpid',:string)
      for i in 1..12
            mp.defMetric("chan#{i}",:double)
      end
  end
end
```

```
defGroup('server1', "omf.ibbt.open.server1") {|node|
    node.addApplication("usrpse_sweeping_wrapper") {|app|
        app.setProperty('gain','20' )
        app.setProperty('spb','1048576')
        app.setProperty('fftsize', '512')
        app.setProperty('args', "10.11.20.1")
        app.setProperty('bps','4')
        app.setProperty('freqbegin','2420000000' )
        app.setProperty('numofchannel', '12')
        app.setProperty('firstchannel','2422500000')
        app.setProperty('channelwidth', '5000000')
        app.setProperty('channeloffset','5000000')

        app.measure('usrpsemp', :samples=>1) do |mp|
        end
    }
}
```

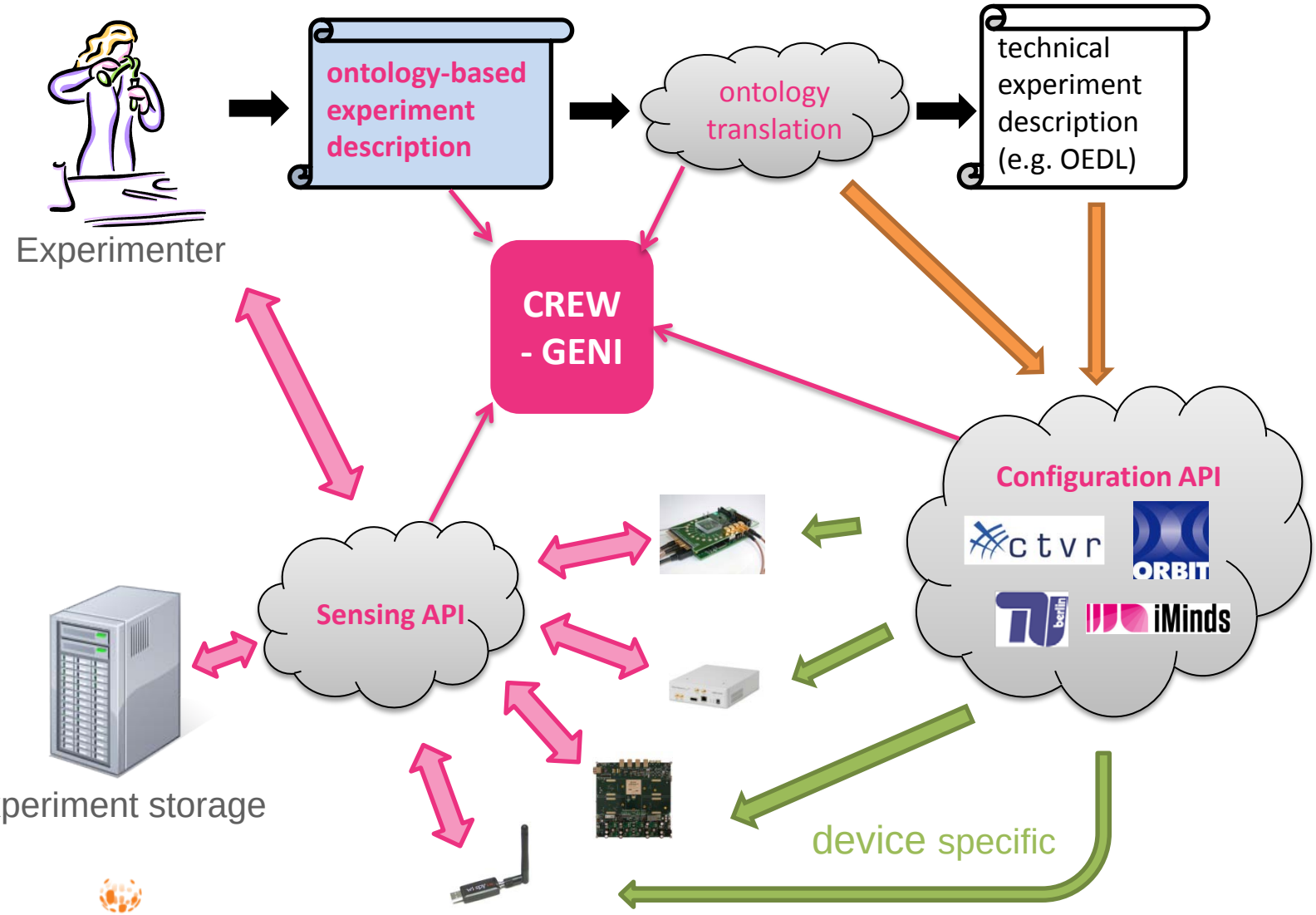
Reservation → Configuration → Experiment definition

ontology-based experiment description **(same for all testbeds & components)**

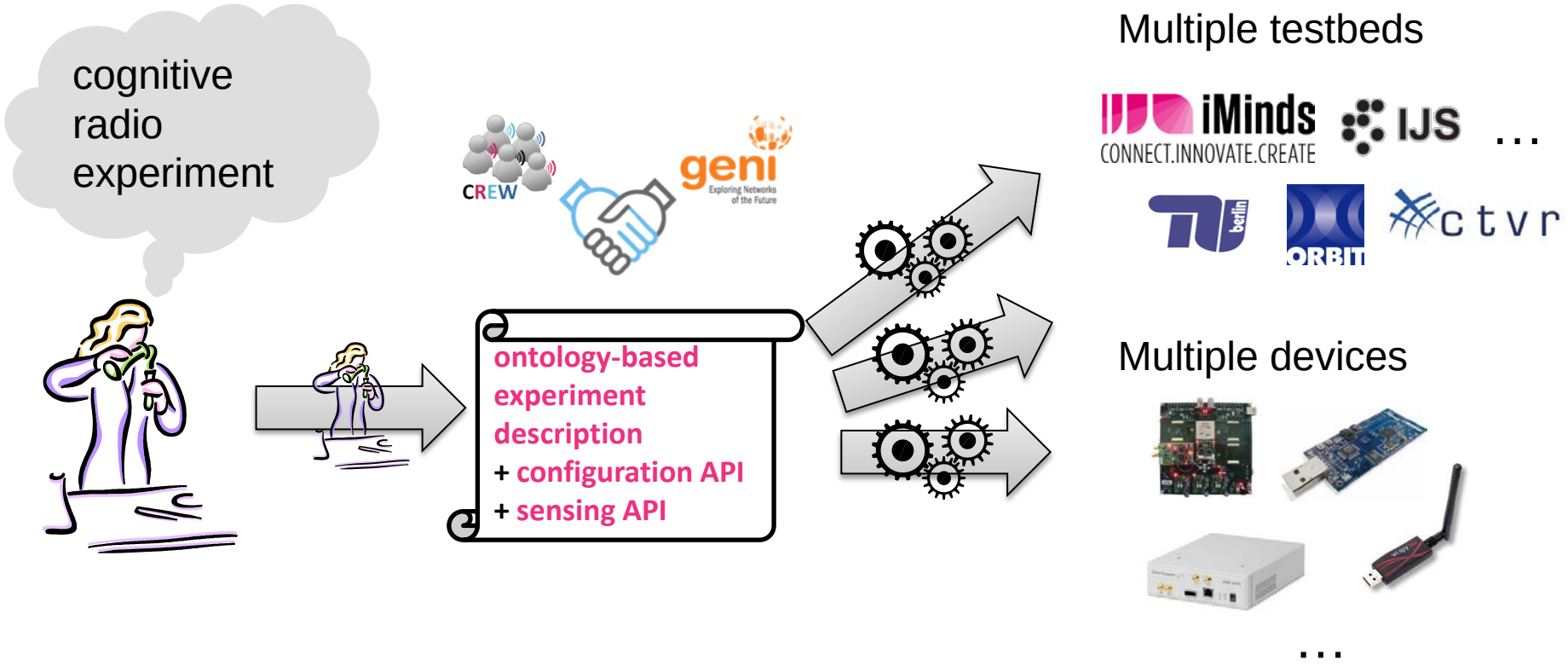
→

technical experiment description **(testbed & component specific)**

GREW-GENI architecture

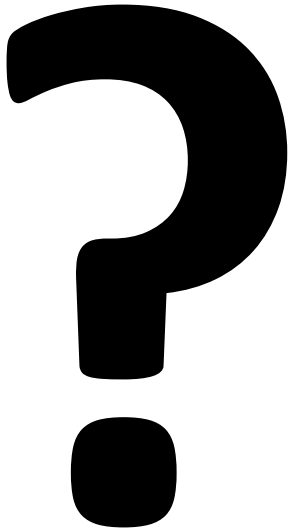


CREW-GENI collaboration



Conclusion: automatic translation allows researchers to run experiments on a wide range of testbeds and devices without extra effort

Q & A



Open call 3

Visit the CREW booth for more info

Contact:

Ingrid.moerman@intec.ugent.be

www.crew-project.eu

The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 258301 (CREW project).